

# PATENT SPECIFICATION

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## DRAWINGS ATTACHED

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## (54) BOLT AND WASHER ASSEMBLY

(71) We, STANDARD PRESSED STEEL CO., a Corporation organised and existing under the Laws of the Commonwealth of Pennsylvania, United States of America, of Jenkintown, Pennsylvania 19046, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a bolt and washer assembly.

With the increased importance of weight considerations in the design of various structural elements, especially in the aerospace field, resort has been made to the use of various abrasion-resistant, but high strength materials such as plastics. Unfortunately, elements made of these materials present various problems when jointed to other elements by rotatable fasteners such as bolts or the like. For example, conventional bolts include a bearing surface that directly contacts the surface of the abrasion-resistant structural element to be joined and the relative sliding movement between the bearing surface and the structural element can cause a wearing away or deformation of the material around the aperture. If the wear or deformations become too large, it becomes necessary to replace the abrasion-resistant structural element or rework the aperture and use special oversize bolts to assemble the joint. The corrective measure taken depends on which alternative is cheaper for the particular structural elements involved, but it should be understood that both alternatives add greatly to the cost of the structure.

In addition to the wear or deformation of the abrasion-resistant element, another problem resulting from the contact and relative rotation of the bolt and the structural element occurs because of scratches that can be formed on the surface of the structural element. These scratches introduce stress concentrations into the structural element and reduce the fatigue strength of

the joint. Fatigue strength is a serious consideration in those applications where the structural element is highly stressed and subject to failure in fatigue.

In an attempt to overcome the above enumerated problems when using a bolt or a similar fastener to assemble a joint including an abrasion-resistant structural element, various attempts have been made to provide a lubricant on the bearing surface of the bolt. While such a technique generally reduces the friction at the interface of the bearing surface and the structural element, it does not eliminate sliding movement at the interface and the problems enumerated above can still occur.

It is an object of this invention, therefore, to provide a fastener assembly that prevents sliding movement of the fastener directly on an associated structural element.

It is another object of this invention to provide a joint including an abrasion-resistant structural element and a bolt and washer assembly that will not deform or scratch the surface of the structural element.

These objects, as well as others, are achieved according to the present invention by providing a bolt and washer assembly comprising a bolt including a threaded shank portion having a head formed at one end, said head having a bearing surface, and an outer end surface opposed to said bearing surface, and a washer having a smooth inner bearing surface complementary to said bearing surface on said bolt and a smooth outer bearing surface opposed to said inner bearing surface, said washer extending around the periphery of the outer end surface of the head and terminating in an annular portion extending over a portion of said outer end surface of said head, the bolt and washer being rotatable relatively to each other.

To reduce friction, a suitable lubricant may be provided at the interface between the bearing surface of the bolt head and the inner bearing surface of the washer and/or, if desired, on the outer bearing surface of the washer.

In use, the bolt and washer assembly is inserted into aligned apertures in a stack of structural elements to be joined and the bolt is thereafter rotated to clamp the joint. As the bolt rotates, the washer does not turn and, accordingly, there is no rotational sliding movement on the structural element.

For a better understanding of the present invention, together with other and further objects thereof, reference is made to the following description, taken in connection with the accompanying drawings.

Referring to the drawings:—

Figure 1 is a perspective view of a bolt and washer assembly in accordance with the present invention; Figure 2 is a side view of the bolt and washer assembly shown in Figure 1 with portions thereof broken away for the sake of clarity, and

Figure 3 is a side view partly in section of a bolt and washer assembly in accordance with the present invention inserted in a pair of structural members to be joined.

Referring first to Figures 1 and 2, a bolt and washer assembly in accordance with the present invention is shown as comprising a bolt 10 having an enlarged head 12 from which a threaded shank portion 14 projects and a washer 16 carried on the head. In this embodiment, head 12 is of the flush fitting type that includes a frusto-conical bearing surface 18 extending from the outer end surface of the head to the outer end of shank 14. It should be understood, of course, that the flush type head is not necessary for the practice of this invention but could be of the protruding type that is joined to the shank by a radial bearing surface projecting from the outer end of the shank. A suitable recess 20 is formed in the end surface of head 12 and is adapted to receive a driving tool for rotating the bolt in a joint. As pointed out previously, shank portion 14 includes a threaded portion and as is usual in the art, the threaded portion is co-operable with a threaded aperture in one of the structural elements to be joined or a nut to clamp the joint.

Washer 16 includes a smooth frusto-conical surface portion 22 that conforms to the frusto-conical bearing surface 18 on head 12 and an annular face portion 23 projecting at an angle from the frusto-conical portion and inwardly a short distance across the end surface of head 12. By this configuration, the washer is captivated or retained with the bolt. It should be noted, however, that a clearance is provided between the washer and the head so that the bolt can rotate with respect to the washers. As best seen in Figure 2, frusto-conical section 22 of washer 16 includes an inner bearing surface 24 that bears against frusto-conical bearing surface 18 and an outer bearing surface 26 located opposite

the inner bearing surface so as to bear on the surface of a structural element to be joined. All of the bearing surfaces are smooth and at least one of the bearing surfaces at the interface of the bearing surface on the head of the bolt and the inner bearing surface of the washer preferably includes a lubricant. In the preferred embodiment disclosed a coating of polytetrafluorethylene is used as a lubricant and the entire surface of the washer includes such a coating to facilitate making the washer and to reduce friction at all bearing surfaces.

Referring to Figure 3, a joint utilising a bolt and washer assembly 10 is illustrated and includes structural elements 28 and 30 having aligned apertures that receive shank 14 of the bolt. The aperture in structural element 28 is countersunk to receive the bolt and washer assembly and in order to provide a flush fit. The relative sizes or included angles of the countersink and the surface 18 may be arranged to accommodate the thickness of frusto-conical section 22 on the washer.

During assembly of the joint, as bolt 10 is rotated by a suitable tool, outer bearing surface 26 seats on the countersunk surface in structural element 28 and bearing surface 18 on the bolt head seats on inner bearing surface 24 on the washer. As the bolt is further rotated, bearing surface 18 slides on inner bearing surface 24 while friction between outer bearing surface 26 and the countersink in the structural element and the clamping force exerted by the fastener on the joint prevent rotation of the washer. In this way, there is no sliding motion on panel 28 that would wear or deform the aperture or scratch the surface of the panel. Accordingly, a bolt and washer assembly according to this invention finds ideal use with abradable structural elements, but it is to be understood that it can be used with structural elements made of other materials.

While there has been described what is at present considered to be the preferred embodiment of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made therein without departing from the invention as defined in the following claims.

WHAT WE CLAIM IS:—

1. A bolt and washer assembly comprising a bolt including a threaded shank portion having a head formed at one end, said head having a bearing surface, and an outer end surface opposed to said bearing surface, and a washer having a smooth inner bearing surface complementary to said bearing surface on said bolt and a smooth outer bearing surface opposed to said inner bearing surface, said washer extending

- around the periphery of the outer end surface of the head and terminating in an annular portion extending over a portion of said outer end surface of said head, the bolt and washer being rotatable relatively to each other.
2. A bolt and washer assembly according to Claim 1 wherein at least one of said bearing surfaces has lubricant thereon.
3. A bolt and washer assembly in accordance with Claim 2 wherein said inner bearing surface on said washer has lubricant thereon.
4. A bolt and washer assembly in accordance with Claim 2 or 3 wherein said outer bearing surface on said washer has lubricant thereon.
5. A bolt and washer assembly in accordance with any one of Claims 2 to 4 wherein said lubricant comprises a coating of polytetrafluorethylene.
6. A bolt and washer assembly in accordance with any one of the preceding claims wherein said bearing surfaces are frusto-conical.
7. A fastened assembly comprising a panel of abradable material having an aperture therein, a bolt having a shank extending in said aperture and a head adjacent said panel at one end of said aperture, and a washer retained on said bolt and having a smooth portion intermediate said head and said panel, the bolt and washer forming an assembly in accordance with any one of the preceding claims.
8. A fastened assembly in accordance with Claim 7 wherein the interface between the bearing surface of the bolt head and the inner bearing surface of the washer has lubricant thereon.
9. A fastened assembly in accordance with Claim 7 or 8 wherein the face of said washer bearing on said panel has lubricant thereon.
10. A fastened assembly in accordance with any one of Claims 7 to 9 wherein said head on said bolt includes a frusto-conical bearing surface and wherein the washer includes a frusto-conical portion adjacent said frusto-conical bearing surface on said head.
11. A bolt and washer assembly constructed and arranged substantially as described herein and shown in the accompanying drawings.
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